The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 27 APR 2004
WIPO PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed Stephen Hordley

Dated 19 April 2004

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

1/77

Patents Act 1977
(Rule 16)

The Patent Office

26SEP03 E839990-1 D03052
P01/7700 0.00-0322490.4

THE PATENT OFFICE
J
25 SEP 2003
LONDON

The Patent Office
Cardiff Road
Newport
Gwent NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1.	Your reference	A30412
2.	Patent application number *(The Patent Office will fill in this part)*	0322490.4
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	BRITISH TELECOMMUNICATIONS public limited company 81 NEWGATE STREET LONDON, EC1A 7AJ, England Registered in England: 1800000
	Patents ADP number *(if you know it)*	~~1867002~~ 6300388001
	If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM
4.	Title of the invention	EXCHANGE CABLING
5.	Name of your agent *(if you have one)*	
	"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	BT GROUP LEGAL INTELLECTUAL PROPERTY DEPARTMENT HOLBORN CENTRE 120 HOLBORN LONDON, EC1N 2TE
	Patents ADP number *(if you know it)*	~~1867001~~ 8591919001

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number			

		Number of earlier application	Date of filing *(day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *(See note (d))*	YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	13
Claim(s)	4
Abstract	1
Drawing(s)	12

10. If you are also filing any of the following, state how may against each item

Priority Documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	YES
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Date:

25 September 2003

LIDBETTER, Timothy Guy Edwin, Authorised Signatory

12. Name and daytime telephone number of person to contact in the United Kingdom **Rod Hillen** **020 7492 8140**

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

DUPLICATE

EXCHANGE CABLING

This invention relates to telecommunications exchange installations and methods of creating a connection and re-routing connections in such exchange installations.

A typical telecommunications exchange building houses a large variety and quantity of equipment such as switches, typically on equipment racks, and connected by cables to and from each other and to the external telecommunications network. In modern exchanges optical fibre cabling is becoming more prevalent due to its superior carrying capacity, ease of handling and other advantages.

One of the main functions of optical fibre plant within an exchange is to manage and route fibres from a particular set of optical equipment to fibres from, for example, an incoming cable from the external telecommunications network. As optical fibre is deployed more abundantly and more deeply into the network, the routing and patching of such fibre, especially within exchanges, is becoming increasingly complicated and expensive. A major problem is the growth in the amount of equipment and the sheer number of connections required. The problem is exacerbated by growth, upgrading and changes within the exchange which result in the need to interconnect new equipment or systems. Although the physical positions of incoming cables rarely change, the new equipment or system will almost certainly be in a different physical location from the old, and in any event will typically need moving or different connections to be made.

The current method of fibre routing within the exchange is achieved with Optical Flexibility Racks (OFRs), which serve as junction or distribution points allowing cables to be routed within the exchange. OFRs can carry hundreds of individually spliced fibres but when they are fully populated, as is often the case, there is severe congestion at the OFRs. It is often difficult to identify, locate and isolate individual fibres in such cases when re-routing of the cable path is necessary, making the task both time-consuming and complicated. Another problem resulting from fibre overcrowding is that fibres are routed across each other in close proximity so that the combined weight presses down on fibres located near the base of OFRs, increasing the risk of circuit failure through increased optical loss and even of fibre breakage.

This problem will become even more critical when higher bit rate systems are employed, as these tend to be more sensitive to increases in optical loss.

The installation and maintenance of optical fibre cabling, its routing and supporting structures such as OFRs take up a significant portion of the total cost, time and effort of installing and cabling a telecommunications exchange system. Current methods to interconnect exchange equipment, or to connect an incoming cable to a rack of exchange equipment typically involve several fibre lengths connected end to end either by means of connectors or splices, or a combination thereof. The path taken by the fibre from the incoming cable to an equipment rack could involve a significant number of connections or splices, especially if the destination equipment rack is physically distant from the incoming cable, for example if the equipment sits on a separate floor from the incoming cable within the exchange building.

Such conventional methods are commonly known and described in e.g. Modular Optical Plant for Access Network: Operational Aspects by D. Brewer et. al (Proc. EFOC & N (Technology and Infrastructure) 1995, at pages 164-167).

Problems associated with the existing method of creating fibre paths by using connectors or splices arise from the inherently delicate nature of joining fibre ends, which is time- and cost-consuming in the need for specialist equipment and expertise. Connections and splicing also inevitably involve optical losses regardless of the quality of the joint. Other problems could arise: for example, stored fibre could "run out" either side of the splice, thereby reducing the number of fibre turns and hence the opportunity to re-splice in the future.

In a first aspect, the present invention provides a telecommunications equipment installation comprising telecommunications equipment optically connected to an optical fibre of an incoming cable of a telecommunications network wherein lengths of blown fibre tube are joined to form a continuous path from the equipment to the optical fibre, via selection means allowing selection of the route taken by the path, and wherein a continuous blown fibre unit extends through the path thereby providing an optical connection between the equipment and the optical fibre.

In a second aspect, the present invention a method of providing an optical connection in a telecommunications equipment installation, between telecommunications equipment and an optical fibre of an incoming cable of a telecommunications network, comprising the steps of joining the ends of lengths of blown fibre tube to provide a continuous path from the equipment to the optical fibre via selection means allowing selection of the route taken by the path, and thereafter, installing a continuous blown fibre unit through the path.

In a third aspect, the present invention provides a method of re-routing a first optical connection in a telecommunications equipment installation between an optical fibre of an incoming cable of a telecommunications network and a first item of telecommunications equipment, wherein the optical fibre is terminated at an optical fibre receiving point, to create a second optical connection between the optical fibre and a second item of telecommunications equipment comprising the steps of breaking the first optical connection at the optical fibre receiving point, joining the ends of the lengths of blown fibre tube (16) to form a continuous path from the optical fibre to the second item of telecommunications equipment via selection means allowing selection of the route taken by the path, and thereafter, installing a continuous blown fibre unit in the path.

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic drawing of a exchange installation using optical fibre cables currently deployed according to the current conventional method;
Figures 2A and 2B are schematic drawings showing the existing method of re-routing the path between an incoming cable and the destination equipment rack using optical fibre cables according to the current conventional method;
Figure 3 is a schematic drawing of an exchange installation according to the present invention;
Figures 4A and 4B are schematic drawings showing a method of re-routing the path between an incoming cable and the destination equipment rack according to the present invention;
Figure 5 is a schematic drawing of another embodiment of an exchange installation according to the present invention;

Figure 6 is a schematic drawing of a further embodiment of an exchange installation according to the present invention;
Figures 7A to 7F show configurations of blown fibre flexibility tube modules (BFTFMs) in single-, two-, three-, four-, five- and six-module builds respectively;
Figure 8 shows a typical build sequence of an exchange installation of the type as shown in Figure 3 above;
Figure 9 shows an instance of incorrect exchange cabling without tube bend management; and
Figures 10A to 10D illustrate the use of positive tube bend management in the BFTFMs described in Figure 8.

Figure 1 shows a typical layout of the current exchange installation of a particular equipment rack (2) within the exchange building, connected to an incoming cable (5). For the avoidance of doubt, an "incoming cable" includes any cable which enters the exchange to connect it with, for example the external telecommunications network.

The incoming cable (5) is typically terminated at a cable chamber joint (CCJ) (8) by a splice (10f) to an internal cable (1c). The CCJ is typically located within same building as the equipment rack although this is not necessarily the case. The CCJ represents the "line side" of the exchange for purposes of fibre routing within the exchange. The equipment rack represents the "equipment side" for purposes of fibre routing within the exchange.

The internal cable (1c) is spliced at one end to the incoming cable at the CCJ, and the other end to a line side flexibility point such as an Optical Flexibility Rack (OFR) (4d).

Flexibility points serve various functions, mainly as a junction or distribution point to allow a user to select and connect a point to any other point within the exchange e.g. from any piece of exchange equipment to any other piece of equipment, or from/to an incoming cable. Flexibility points also provide an interface between the typically high fibre count incoming cable and an internal cable, terminate incoming fibres onto splice trays for safe storage, provide easy access to each individual fibre and serve as testing points. We are however for present purposes interested only in their ability to connect line side fibre to equipment side fibre. Typically, at least two flexibility points are used together, more usually in side-by-side pairs, to facilitate the routing of fibres within the

exchange – one on the line side and one on the equipment side. Such groupings of flexibility points are within this document called flexibility suites. For the avoidance of doubt, "flexibility points" and "flexibility suites" in this discussion are generic references to OFRs and OFR suites for fibre cables, and to Blown Fibre Tube Flexibility Modules (BFTFMs) and BFTFM suites (discussed below in connection with Figure 3 onwards).

OFR suites (4a and 4b, 4c and 4d) allow fibres terminated in line side flexibility points and equipment side flexibility points to be spliced to each other on a splice tray dedicated to a fibre or pair of fibres. Fibre jumpers (3a, 3b) are spliced between the pair of OFRs. Another fibre cable (1b) connects an equipment side OFR (4c) to the next line side OFR (4b). The first OFR suite (comprising 4c and 4d) in Figure 1 is located near the CCJ, and the last suite (comprising 4a and 4b) is that located near the destination equipment rack. In an actual exchange, a number of OFR suites distribute and route optical cable; the "last OFR suite" (comprising 4a and 4b) would be the suite located closest to the destination equipment rack (2).

The prior art shown Figure 1 depicts the most basic layout involving two pairs of OFRs. In practice, depending on the exchange building layout and the complexity and length of the optical path, any number of OFR suites can be used to describe the optical path to the equipment rack, which would have an effect on the number of OFR suites and splices or connections in the optical path. For the basic configuration shown in Figure 1, a minimum of six splices (10a to 10f) is required.

The prior art shown in Figures 2A and 2B illustrate how, according to current practices, an optical path is re-routed from a first equipment rack (2) to second equipment rack (12) in a conventional optical fibre installation.

In the prior art installation shown in Figure 2A, an optical path connects the incoming cable (5) to the existing equipment rack (2). There are six splices (10a to 10f) between the incoming cable (5) and the equipment rack (2). To re-route the optical path to the new equipment (12) at a different location, the splice at the OFR (10e) will have to be broken in the old path. The other splices along the old path (10a to 10d) could be broken if required. Figure 2B shows the optical path to the new equipment rack (12) through two OFR suites (4). Five new splices (10h to 10l) are made to create the new optical path from the line side OFR (4d) adjacent to the CCJ (8). As discussed above,

splicing is a complicated and delicate procedure requiring considerable specialist skill. Each splice will inevitably give rise to signal attenuation and the creation of new splices will necessarily involve the risk of a poorly-made joint in the optical path. The cable used in the old optical path may be removed and if not suitable for re-use, as is generally the case, it will be discarded. Alternatively it may be left in place, thus further adding to the problem of overcrowding within the exchange.

Figure 3 shows a first embodiment of the invention. Instead of separate lengths of fibre connecting the OFRs which need to be joined (e.g. 1a, 3a, 1b, 3b and 1c in Figure 1), a blown fibre unit (BFU) is installed from the OFR (4) to the equipment rack (2) to effect the connection between the incoming cable (5) and the equipment rack (2).

The incoming cable (5) is terminated at a line side OFR (4) in the usual way as described in connection with Figure 1 above. An internal cable (1) is spliced to the incoming cable at the CCJ and is spliced at its other end on a splice tray housed in a conventional line side OFR (4) in the usual way as described in connection with Figure 1 above. From the line side OFR (4), lengths of blown fibre tube (BFT) or bundles thereof (16) are patched through to the equipment rack (2) via a number of flexibility points for BFTs which in this case are called Blown Fibre Tube Flexibility Modules (BFTFMs) (14), comprising a single tube and push in BFT connectors. As noted above in connection with Figure 1, BFTFMs are flexibility points allowing the distribution and routing of – in this case – blown fibre tubes throughout the exchange from any point to any other point. As with OFRs, BFTFMs are most commonly employed in pairs, or suites, one on the line side (14b) and one on the equipment side (14a). The OFR (4) at which the internal cable (1) is spliced forms one half of a flexibility suite, the other half being a BFTFM (14c) on the equipment side. This flexibility suite located adjacent to the internal cable (1) will within this document be known as the primary flexibility suite. All other flexibility suites not being the primary flexibility suite shall be known as secondary flexibility suite(s).

The BFTs (16a, 16b) in this embodiment are installed between one equipment side BFTFM to the next line side BFTFM along the path to the equipment rack. The path is completed by installing BF patch tubes (17a, 17b) between the flexibility suites (14c and 4, 14a and 1b), so that a completed BFT path is created between the OFR (4) and

the equipment rack, ready to receive a BFU. BFU is then installed by blowing from either end of the path, i.e. from the equipment rack (2) or from the OFR (4).

Figure 3 shows just two flexibility suites in use, but as discussed above, further flexibility suites can be employed depending on the physical distance, building layout and path taken from the originating point to the destination point.

By way of example, if the scenario involves the CCJ (8) being located in the basement, the primary flexibility suite (4) on the ground floor and the equipment rack (2) on the first floor, the installation could involve the following steps:

1. Install the CCJ (8).
2. Terminate incoming cable (5) on CCJ.
3. Install internal cable (1) between CCJ and OFR of the primary flexibility suite (4)
4. At CCJ splice all fibres from incoming cable (5) to internal cable (1).
5. Terminate all fibres from the internal cable (1) on the OFR (4).
6. Install BFT (16b) from equipment side of the BFTFM (14c) in the primary flexibility suite to line side BFTFM (14b) on first floor.
7. Install BFT (16a) from the equipment rack (2) on the first floor to the equipment side of the first floor BFTFM (14a).
8. Patch BFT path at flexibility suites using BF patch tubes (17a, 17b) cut to length on site. "Patch tubes" are short lengths of single tubes to patch between a tube on the equipment side of the BFTFM to a tube on the line side of the BFTFM.
9. Install BFU. Blowing can be carried out at either the equipment rack (2) or at the OFR (4).
10. At the OFR splice internal cable (1) to the installed BFU.
11. At the equipment rack splice connectorised pigtails from the equipment rack (2) to the installed BFU.

It would be clear to the skilled person that a major advantage of using a single unbroken length of blown fibre unit to interconnect optical equipment to the external network, is the removal of known reliability weak points in the form of splices and/or connector points. There may also be benefits in increasing the available power budget by removing optical losses associated with connectors and splices. In the basic arrangement described in this Figure 3, there are only three splices (10a, 10b, 10c) per

fibre between the CCJ and the equipment rack, compared to six in the conventional arrangement described in Figure 1. Time- and cost-savings are achieved as expensive and delicate splicing and connectorising is reduced to a minimum.

Figures 4A and 4B show how an optical path connecting an existing equipment rack (2) can be changed to the new equipment rack (12) in accordance with the invention.

Figure 4A shows the existing optical path between the incoming cable (5) and the old equipment rack (2) though two flexibility suites (14). Figure 4B shows how only two splices (10a, 10b) have to be broken in the existing optical path, which compares favourably with equivalent under the conventional method which requires five breaks (see Figure 2). After the splices are broken the blown fibre unit is removed. The path is then re-configured, using BFT (16) between flexibility suites (14d and 14e, 14c and 4), and single tube BFT patch leads (17c, 17d) between the flexibility points within a suite. BFU is then installed as described above in connection with Figure 3, by blowing from either end of the path, i.e. from the new equipment rack (12) or from the OFR (4). Only two new splices are made (10c, 10d) at the OFR and the new equipment rack.

It can be seen that yet another advantage of the invention is flexibility in re-routing and user-friendliness, compared to conventional techniques requiring installation of heavy cables. The resulting blown fibre installation is relatively compact, when compared to a connectorised fibre installation.

Figures 5 and 6 show refinements of the arrangements described in Figure 3 above, being embodiments of the invention which further reduce the number of splices required.

In Figure 5, the CCJ (8) and the splice thereat is removed. The incoming cable (5) is instead directly spliced to the blown fibre unit (when installed) at the line side OFR (4). In this arrangement, there are only two splices per fibre. By way of example, the following are typical steps that can be taken to create this installation where the incoming cable enters the building in the basement, the primary flexibility suite (4) is on the ground floor and the equipment rack is located on the first floor:

1. Route incoming cable (5) from cable chamber to the OFR of the primary flexibility suite (4).
2. Terminate all fibres of the incoming cable (5) on the OFR (4). Install BFT (16a) from equipment side of ground floor BFTFM (14c) of the primary flexibility suite to line side BFTFM (14b) on first floor.
3. Install BFT from the equipment rack (2) to the equipment side of the first floor BFTFM (14a).
4. Patch BFT path through all BFTFMs using BF patch tubes (17a, 17b) cut to length on site.
5. Install BFU. Blowing can be carried out at either the equipment rack or at the OFR.
6. At the OFR splice incoming cable (5) to the installed BFU.
7. At the equipment rack splice connectorised pigtails from the equipment rack (2) to the installed BFU.

The arrangement in Figure 6 allows a connection between the equipment rack (2) and the incoming cable (5) with just a single splice (10) at the OFR (4). In this case, BFT is installed directly from the equipment rack to the equipment side of the BFTFM located nearest to the equipment rack (14a). BFU is installed in the manner discussed above against Figure 3. By way of example, the following are typical steps that can be taken to create this installation where the incoming cable enters the building in the basement, the primary flexibility suite (4) is on the ground floor and the equipment rack is located on the first floor:

1. Route incoming cable (5) from cable chamber to the OFR (4) of the primary flexibility suite.
2. Terminate all fibres of the incoming cable on the OFR (4).
3. Install BFT (16b) from equipment side of ground floor BFTFM of the primary flexibility suite (14c) to line side BFTFM on first floor (14b).
4. Install BFT (16a) from the equipment rack (2) to the equipment side of the first floor BFTFM (14a).
5. Patch BFT path through all BFTFMs using BF patch tubes (17a, 17b) cut to length on site.
6. Install pre-connectorised BFU; blowing to be carried out at equipment rack.
7. At the OFR splice incoming cable (5) to BFU.

Figures 7A to 7F respectively show possible designs of BFTFMs and BFTFM suites in various configurations, from a single module to a six-module build. These show that while a single BFTFM may be used as a flexibility point, multiple-modules are preferred and their modularity allows flexibility in use and scope for growth.

In a preferred embodiment, BFTFMs incorporate positive tube bend management for optimised BFU installation. Further discussion of this technique is provided below in the discussion of Figures 9 and 10, but in brief this helps prevent installed optical fibres from being bent at less than their minimum permissible bend radius.

Figure 7A shows a single module BFTFM. Two versions are available that respectively allow cable entry from left or right. The example shown allows cable to be fed from the left. A single unit like this would be mounted on the back of a flexibility point such as an OFR to provide the first building block of flexibility suite, in particular the suite most adjacent to the CCJ or the incoming cable.

Figure 7B shows two BFTFM modules mounted back to back to create a line and equipment side flexibility suite. Generally, two modules are the minimum requirement to provide line and equipment side flexibility.

Figure 7C shows a further BFTFM module mounted on top of the arrangement of Figure 7B. Such an arrangement may be required for example, where there is uneven growth of the demand for the equipment side modules, compared to that for line side modules.

Figure 7D shows that further build can also be carried out to the side from one end of the suite. In this case as cable entry is from the left hand side, further modules would be added to the right.

Figures 7E and 7F show five- and six-module configurations to illustrate the potential for growth in the use of BFTFMs.

Figure 8 shows a typical build sequence for the installation described in Figure 6 above using a generic type of OFR. The following steps accord with the numbering against the drawings:

Installing the primary flexibility suite (4 and 14c of Figure 3)

1. Install OFR (rear covers have been removed in the drawing for clarity) (4). Install incoming cables (5) and terminate fibres on single circuit splice trays. Cables can enter either from above or below.
2. Install one BFTFM (14c) adjacent to the rear of OFR. Each BFTFM can typically accommodate 384 individual BF tubes, the equivalent of 4x96 fibre cables. A second and third BFTFM can be added to the flexibility suite to accommodate typically 1152 individual BF tubes.
3. Install vertical cable tray (20), mandrel adapter (22) and internal bend mandrel (24). The mandrels positively manage the fibre tube bend to prevent over-bending. In this instance the cable routes upwards.

Installing subsequent secondary flexibility suite (e.g. 14a and 14b of Figure 3)

4. Install vertical cable tray (26), support frame uprights (28) and frame strap (30) on exchange floor.
5. Add outer bend mandrel (32) and line side BFTFM (14b).
6. Install second vertical cable tray (26), equipment side BFTFM (14a), mandrel adapter and internal bend mandrel.

The secondary flexibility suite is now ready to accept BF tubing. The installation shown can accommodate up to 384 BF patch tubes.

Installing BF tubing

7. The butt of the BF tube (16) is cut level with the edge of the BFTFM (14). Each tube contained is routed over the plastic tube mandrels so that its bend radius is controlled. Tubes are cut to length and plugged into the push fit bulk head fittings which are in turn located into the appropriate hole in the patch panel.

8. Illustration of interface with the vertical cable tray - upwards.
9. Illustration of interface with the vertical cable tray - downwards.

We turn now to Figures 9 and 10 which help explain the use of positive bend management in the context of a telecommunications exchange. As noted above, this technique addresses problems arising from bending a fibre at a radius smaller than its minimum permissible bend radius. As is well known, bending an optical fibre too tightly is likely to result in significant optical losses and/or mechanical fibre damage. Bundles of optical fibre have larger minimum permissible bend radii than those of their constituent fibres. Controlling and managing the fibre bend (as opposed to simply allowing the fibre to find its own path from flexibility suite to flexibility suite) helps prevent optical tubes or fibres from being kinked or bent to a tight radius which may impede blown fibre installation and/or optimal fibre performance. The fibre could be confined within a prescribed path, or simply guided along a curve describing an ideal radius that could be at or near the minimum permissible bend limit.

This characteristic of optical fibre is a particular problem in large telecommunications exchanges. By way of example, British Telecommunications plc has to date more than 5,000 exchanges throughout the United Kingdom, of which some 200 serve over 20,000 customers each. The largest exchanges have multiple floors, hundreds of equipment racks and a very high number of fibre and copper cables routed around and throughout the exchange building. As time progresses, the exchange becomes more populated and changes to equipment, customer needs etc., necessitate re-routing and re-termination of cables. It has been found that the routes taken by cables, if uncontrolled, may impair the performance of the optical fibre. For example, if a jumper cable is re-used it will have to be cut and re-connected – very often it may be too short to reach easily between the two sides and may have to be stretched tight thus compromising minimum bend radius dimensions, a highlighted in Figure 9. This of course affects fibre and circuit performance.

Figure 10 refers to the BFTFMs discussed in connection with Figure 8 above, and highlights how the technique of positive tube bend management may be used. Figure 10A and 10B show where cable bend can be controlled and managed (40) in a typical BFTFM setup.

Tube bend management apparatus can take the form of curved guides or mandrels – (e.g. 24, 32 in Figure 8) – around or against which the tubes are wrapped. The degree of curve depends on the exact type of cable tube being used but in the UK this would typically be a radius of about 50mm.

Figures 10C and 10D show where and how tubes (16) can be subject to positive tube bend management in a BFTFM of the type discussed in connection with Figure 8. The bend control mandrels (24) allow the optical fibre (16) to be guided in a controlled manner around a curve of a radius suitable for it, preventing overly tight cable routing.

Although the foregoing discussion concerns mainly a connection created by the invention between an equipment rack and an incoming cable connecting the exchange to the external telecommunications network, the skilled person would easily recognise that the invention can be deployed with similar effects or advantages to connect any other originating point to any destination point within or outside of the exchange. Furthermore, while the specific description is made in the context of telecommunication exchange buildings, it would be clear that the invention can have applications in any other environment where blown fibre technology according to the invention can be used in place of conventional connectorised and/or spliced optical fibre or current BFT management practices. In particular, the invention may be used in a Local Area Network (LAN) environment.

The skilled person would also appreciate that the invention is not limited to use in a new set-up ready to be cabled, nor to one which is already cabled in a manner as described herein. The inventive aspect concerning re-routing of optical paths, in particular, can be applied even in a conventional installation, to gradually migrate the inventive method into such convention set-ups. The benefits of using the invention can be realised even in such applications.

Claims:

1. A telecommunications equipment installation comprising telecommunications equipment (2) optically connected to an optical fibre (1) of an incoming cable (5) of a telecommunications network wherein lengths of blown fibre tube (16) are joined to form a continuous path from the equipment to the optical fibre, via selection means allowing selection of the route taken by the path (14a and 14b, 14c and 4), and wherein a continuous blown fibre unit extends through the path thereby providing an optical connection between the equipment and the optical fibre.

2. An installation according to claim 1 wherein the selection means allows for re-selection of the route taken by the path.

3. An installation according to claim 1 or 2 wherein the selection means includes means for ends of selected blown fibre tubes to be joined thereat in an array.

4. An installation according to claim 3 wherein the ends of the lengths of blown fibre tube are joined to each other with intermediate blown fibre tubes (17).

5. An installation according to any preceding claim including a plurality of selection means,
wherein primary selection means include an optical fibre receiving point to receive optical fibre (4) and a blown fibre tube receiving point to receive blown fibre tube (14c), the points being located in proximity to each other, and
secondary selection means include a plurality of blown fibre tube receiving points (14a and 14b) to receive blown fibre tube, the points being located in proximity to each other.

6. An installation according to claim 5 wherein the primary selection means is located in greater proximity to the incoming cable (5) of a telecommunications network, than is the secondary flexibility suite to the incoming cable.

7. An installation according to any of claim 5 or 6 wherein

the primary selection means includes a line-side optical fibre receiving point (4) and an equipment-side blown fibre tube receiving point (14c), and
the secondary selection means includes a line-side blown fibre tube receiving point (14b) and an equipment-side blown fibre tube receiving point (14a).

8. An installation according to claim 7 wherein the optical fibre of the incoming cable is terminated at the line-side optical fibre receiving point (4) of the primary selection means.

9. An installation according to claim 8 wherein
the path from the primary selection means to the telecommunications equipment is formed by joined lengths of blown fibre tube extending
from the line-side optical fibre receiving point (4) of the primary selection means to the equipment-side blown fibre tube receiving point (14c) in the primary selection means by means of an intermediate blown fibre tube (17b);
from the equipment-side blown fibre tube receiving point (14c) in the primary selection means to the line-side blown fibre tube receiving point (14b) in the secondary flexibility suite,
from the line-side blown fibre tube receiving point (14b) in the secondary selection means to the equipment-side blown fibre tube receiving point (14a) in the secondary selection means by means of intermediate blown fibre tubes (17a), and
from the equipment-side blown fibre tube receiving point (14a) in the secondary selection means to the telecommunications equipment (2).

10. An installation according to any preceding claim including bend control means to control the bend radius of the blown fibre tube (24).

11. An installation according to any preceding claim wherein the selection means includes bend control means to control the bend radius of the blown fibre tube (24).

12. A method of providing an optical connection in a telecommunications equipment installation, between telecommunications equipment (2) and an optical fibre (1) of an incoming cable (5) of a telecommunications network,
comprising the steps of:
joining the ends of lengths of blown fibre tube (16)

to provide a continuous path from the equipment to the optical fibre via selection means allowing selection of the route taken by the path (14a and 14b, 14c and 4), and thereafter, installing a continuous blown fibre unit through the path.

13. A method of re-routing a first optical connection in a telecommunications equipment installation between an optical fibre (1) of an incoming cable (5) of a telecommunications network and a first item of telecommunications equipment (2), wherein the optical fibre is terminated at an optical fibre receiving point (14c), to create a second optical connection between the optical fibre and a second item of telecommunications equipment (12) comprising the steps of: breaking the first optical connection at the optical fibre receiving point, joining the ends of the lengths of blown fibre tube (16) to form a continuous path from the optical fibre to the second item of telecommunications equipment via selection means allowing selection of the route taken by the path (14a and 14b, 14c and 4), and thereafter, installing a continuous blown fibre unit in the path.

14. A method according to claim 12 or 13 wherein the continuous blown fibre unit is installed in the path by blowing from an equipment rack housing the telecommunications equipment (2, 12).

15. A method according to claim 12 or 13 wherein the continuous blown fibre unit is installed in the path by blowing to an equipment rack housing the telecommunications equipment (2, 12).

16. A method according any of claims 12 to 15 wherein the continuous blown fibre unit is connectorised prior to installation.

17. An installation substantially as described in accordance with the drawings.

18. A method of creating a connection in a telecommunications equipment installation substantially as described in accordance with the drawings.

19. A method of re-routing a connection in a telecommunications equipment installation substantially as described in accordance with the drawings.

ABSTRACT

EXCHANGE CABLING

A telecommunications equipment installation comprising telecommunications equipment optically connected to an optical fibre of an incoming cable of a telecommunications network, wherein lengths of blown fibre tube are joined to form a continuous path from the equipment to the optical fibre, via selection means allowing selection of the route taken by the path, and wherein a continuous blown fibre unit extends through the path thereby providing an optical connection between the equipment and the optical fibre.

(FIGURE 3)

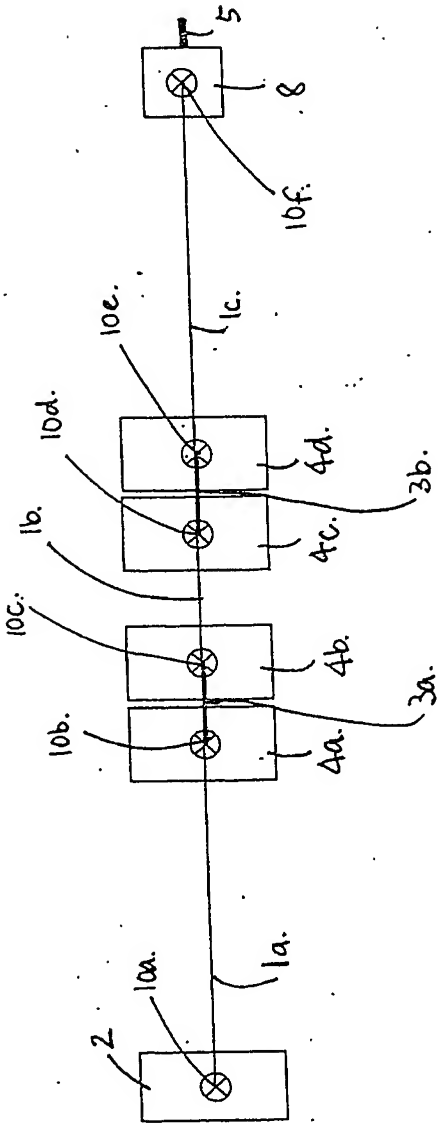

FIGURE 1

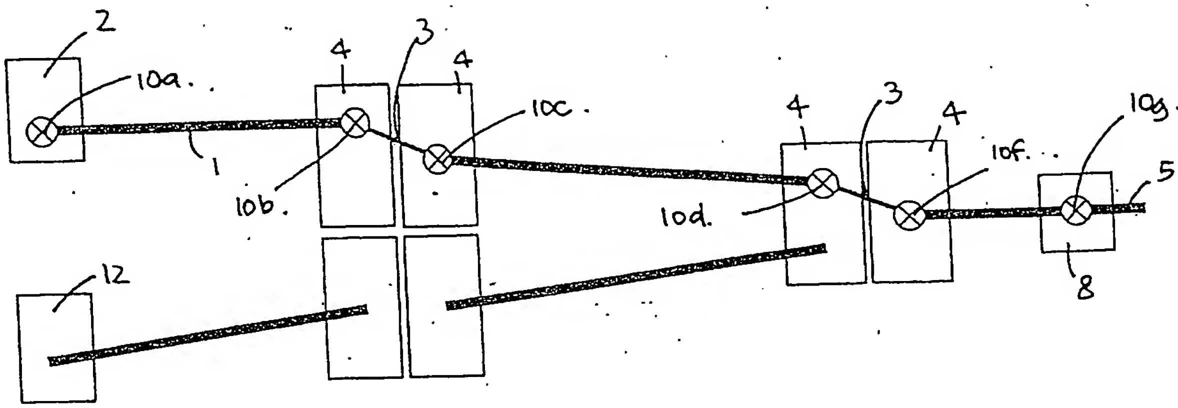

FIGURE 2A

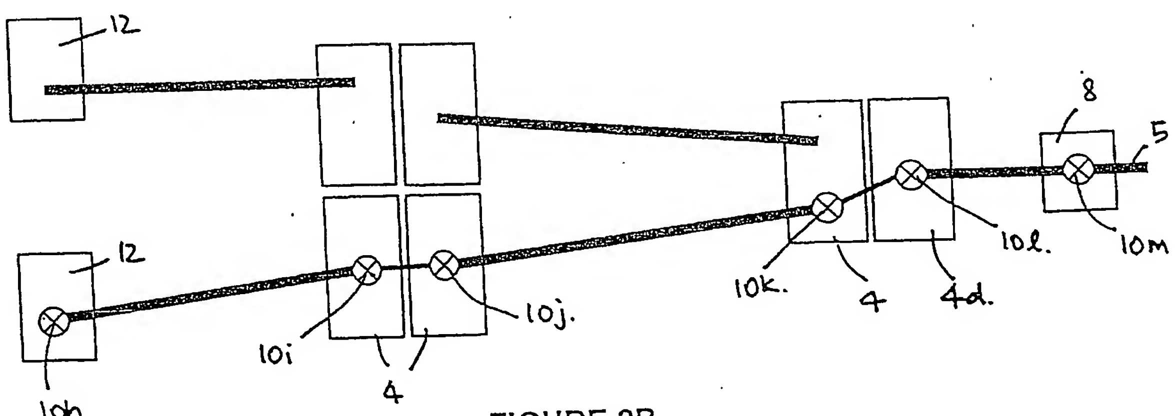

FIGURE 2B

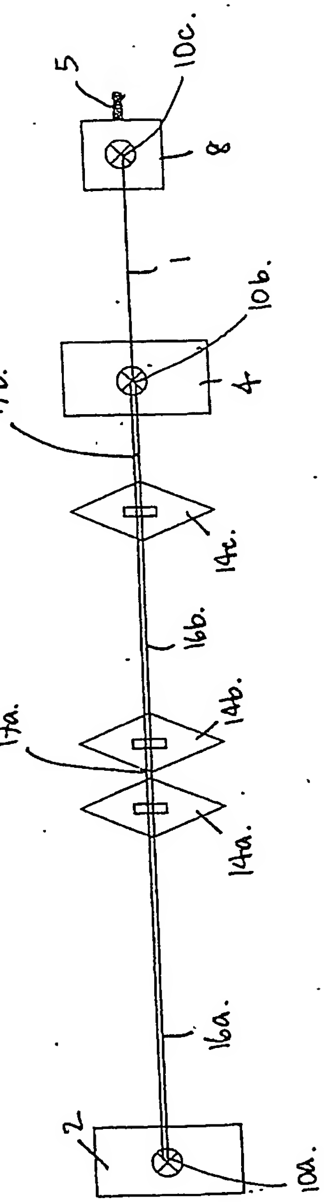

FIGURE 3

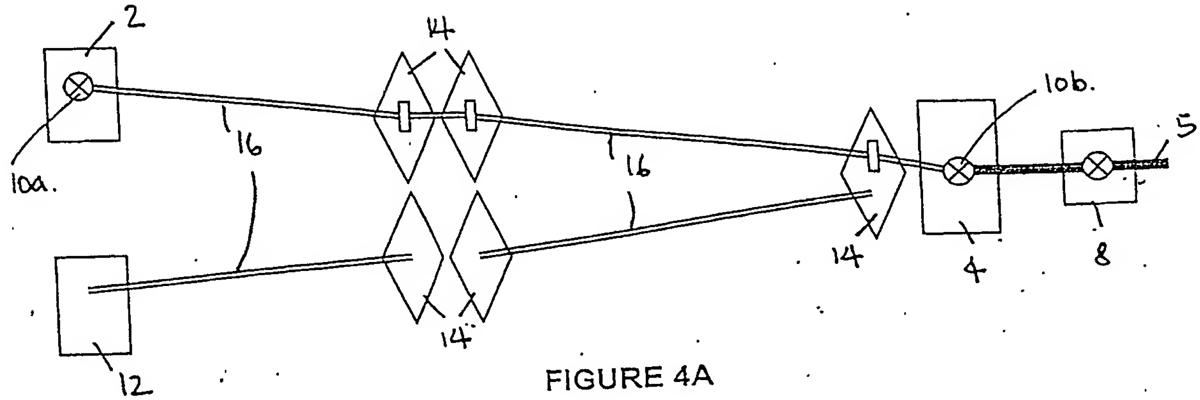

FIGURE 4A

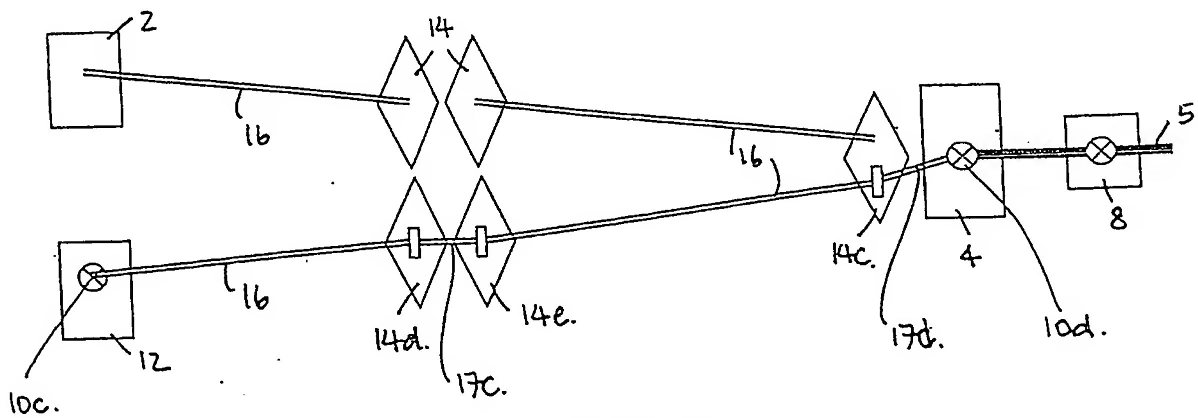

FIGURE 4B

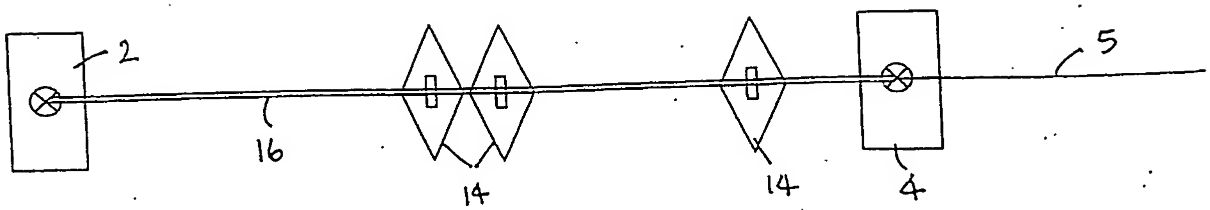

FIGURE 5

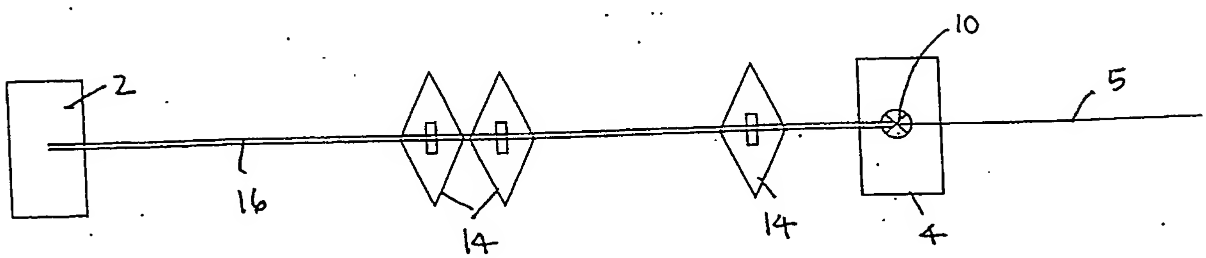

FIGURE 6

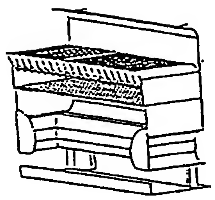

FIGURE 7A

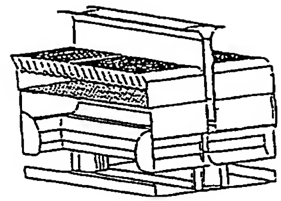

FIGURE 7B

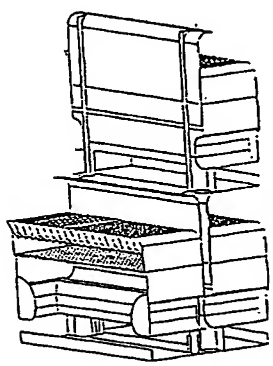

FIGURE 7C

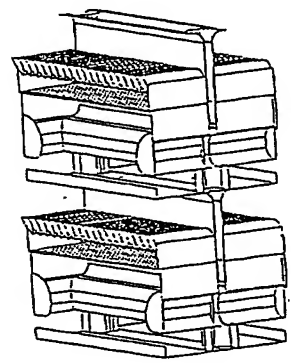

FIGURE 7D

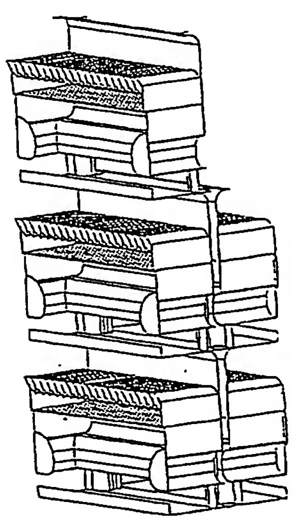

FIGURE 7E

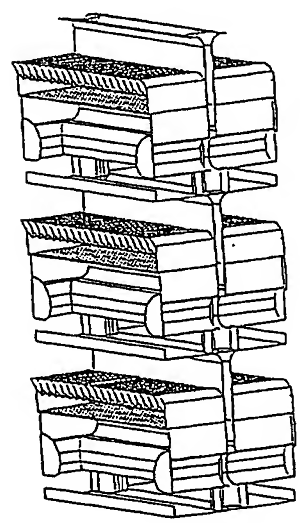

FIGURE 7F

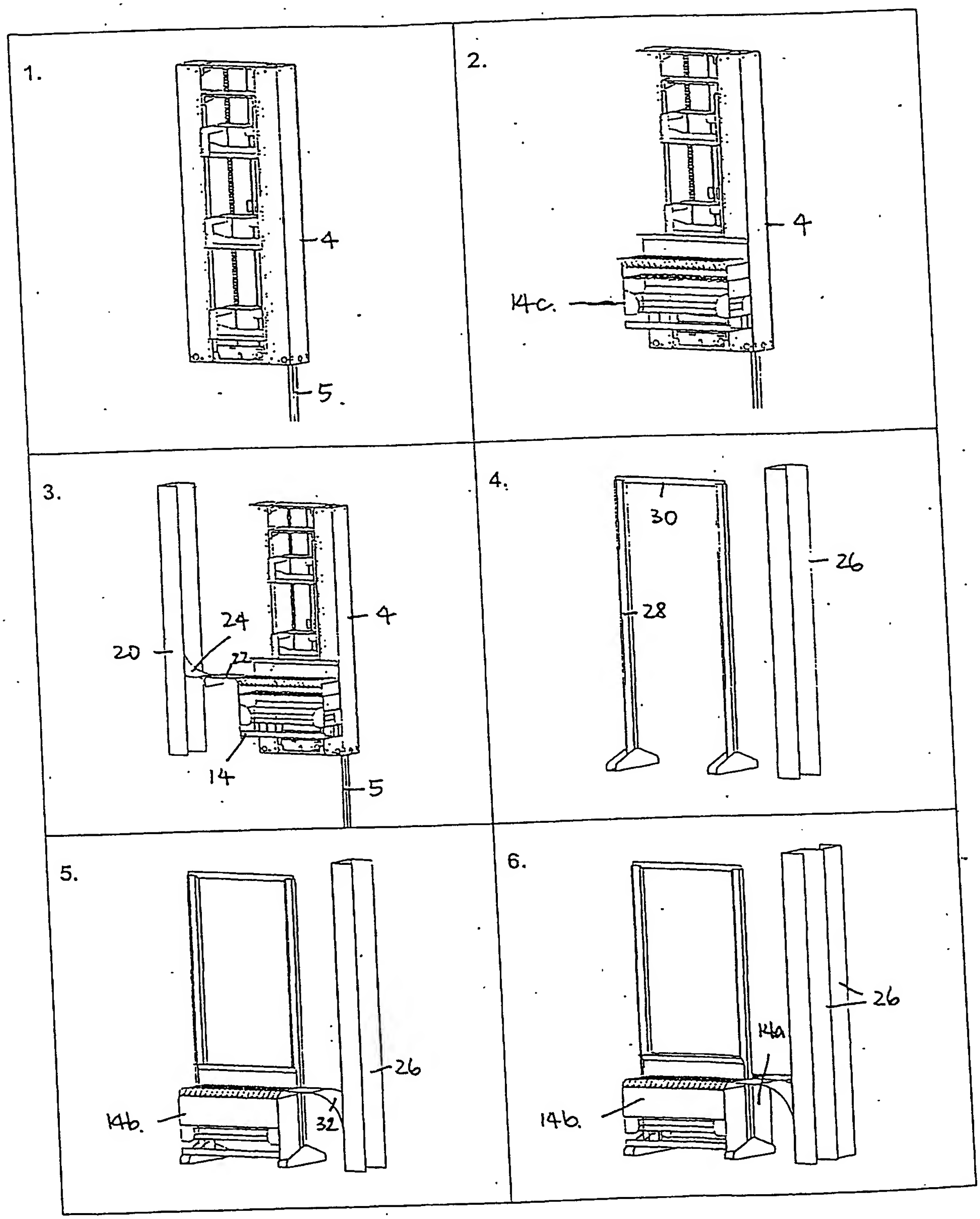

FIGURE 8

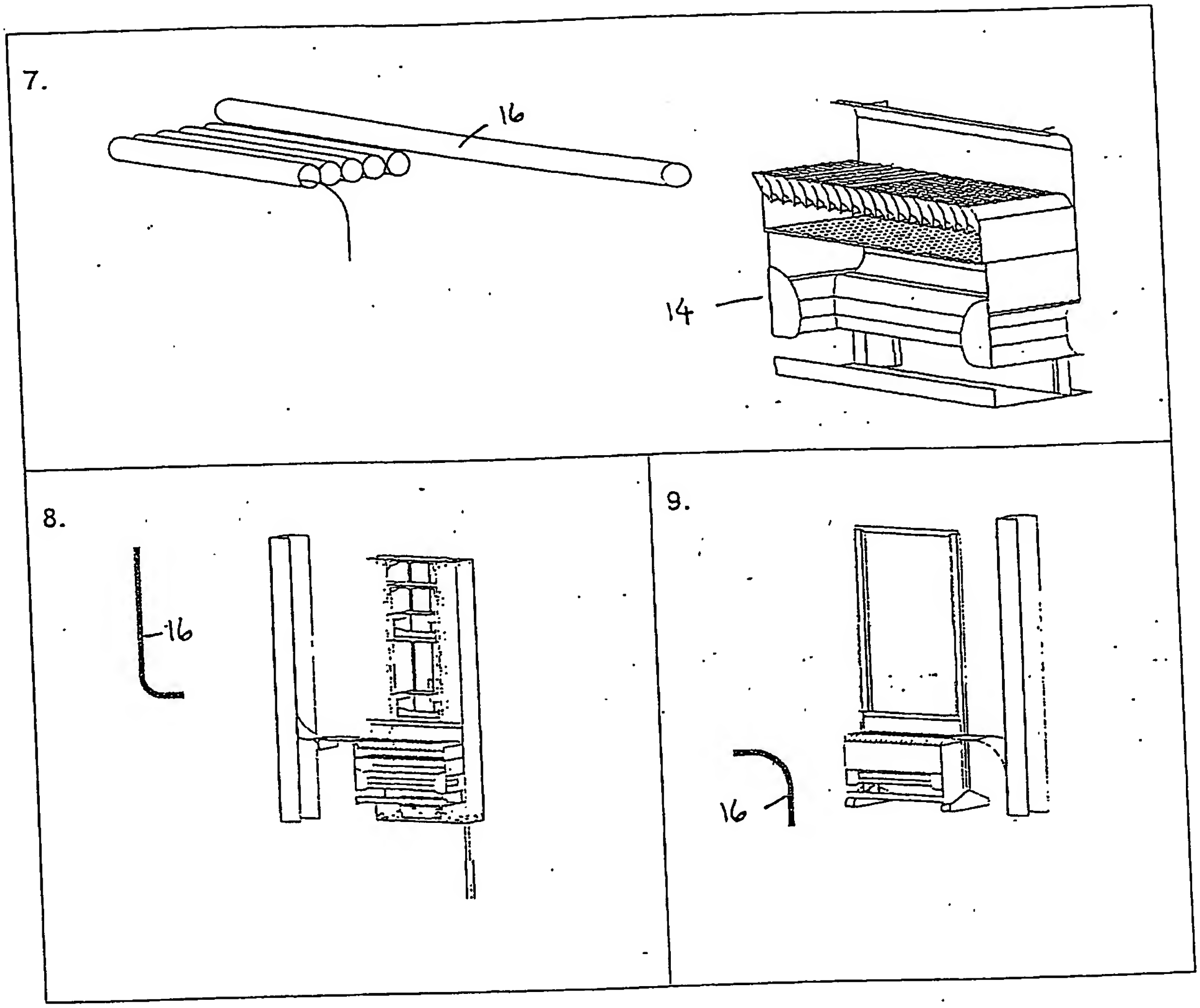

FIGURE 8

C

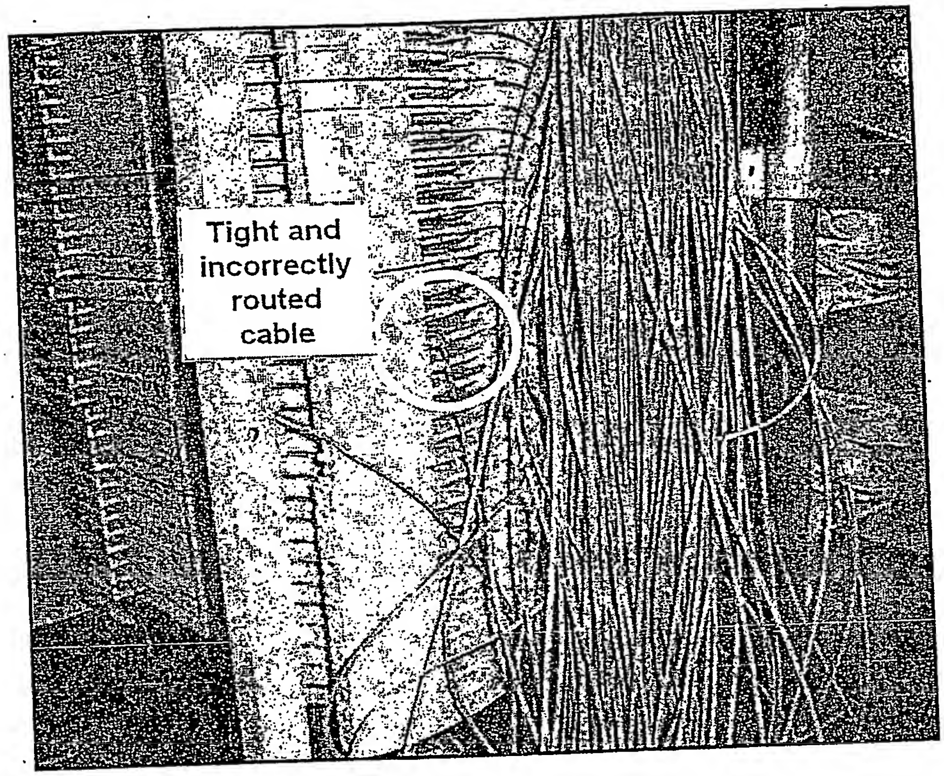

FIGURE 9

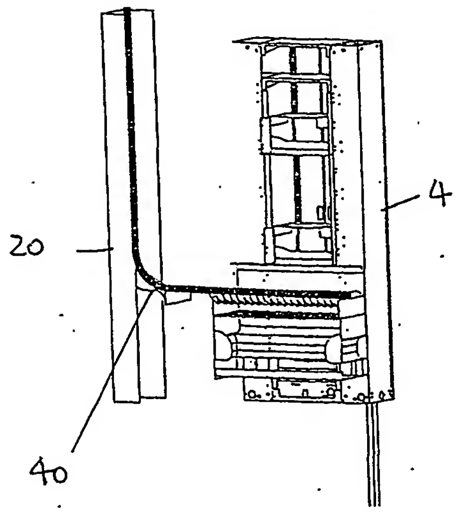

FIGURE 10A

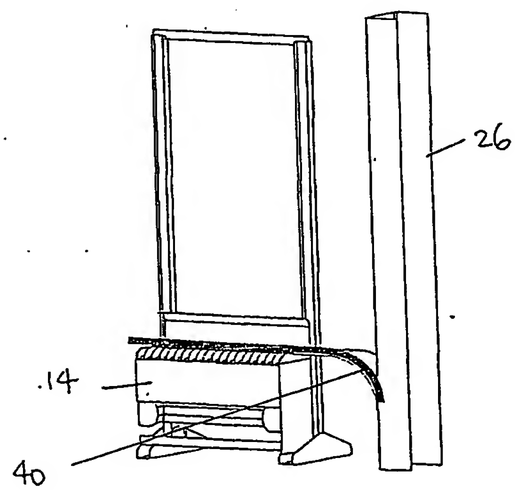

FIGURE 10B

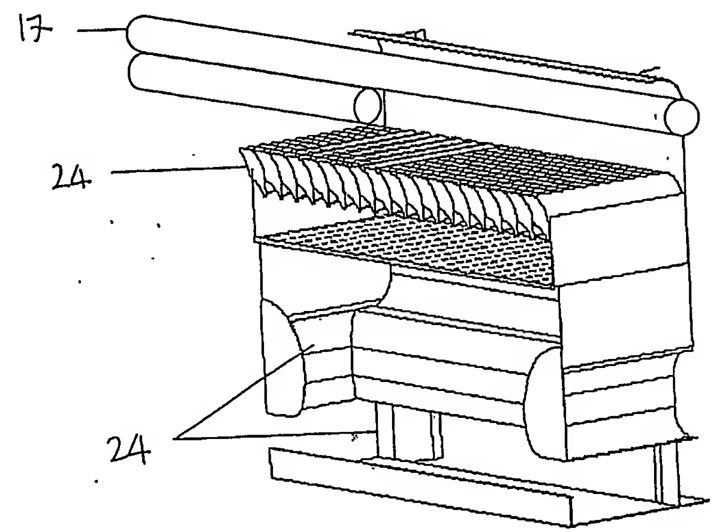

FIGURE 10C

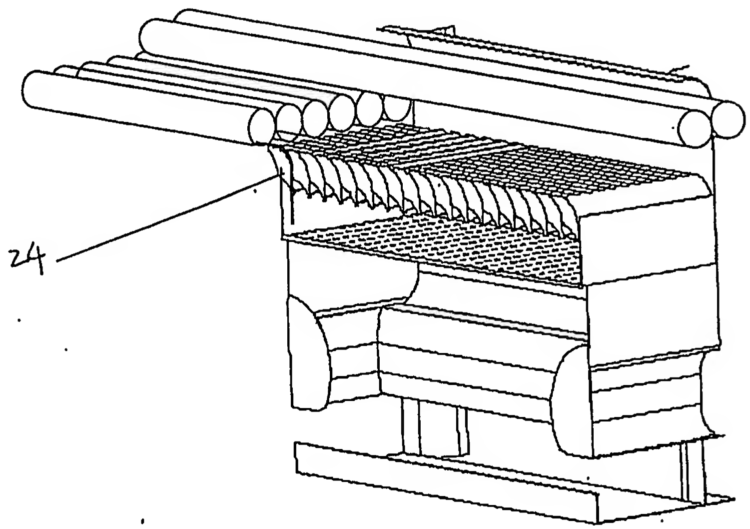

FIGURE 10D

PCT/GB2004/001370